

The Examiner objected to Claim 17 under 37 CFR 1.75(c) as being of improper dependent form for failing to further limit the subject-matter of a previous claim. The above-amendments cancel this claim.

The Examiner stated that Claims 8, 9, 11-18, 19-21 are provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over Claims 1-6, 9, 12-17, 20 of co-pending application No. 10/765,647 in view of Shul, et al (US 5,624,529).

Applicant traverses this rejection. To sustain a rejection under 35 U.S.C. 103, the Examiner must show that the combined references teach each of the elements of the claim or that there is some motivation in the art for altering one of the teachings to arrive at the combined set of teachings. "The mere fact that a reference could be modified to produce the patented invention would not make the modification obvious unless it is suggested by the prior art." (*Libbey-Owens-Ford v. BOC Group*, 4 USPQ 2d 1097, 1103). "When the PTO asserts that there is an explicit or implicit teaching or suggestion in the prior art, it must indicate where such a teaching or suggestion appears in the reference" (*In re Rijckaert*, 28 USPQ2d, 1955, 1957). In addition, the Examiner must show that there is some motivation in the art that would cause someone of ordinary skill to combine the references, and that in making the combination, there was a reasonable expectation of success. Where the claimed subject matter has been rejected as obvious in view of a combination of prior art references, a proper analysis under section 103 requires, *inter alia*, consideration of two factors: (1) whether the prior art would have suggested to those of ordinary skill in the art that they should make the claimed composition or device, or carry out the claimed process; and (2) whether the prior art would also have revealed that in so making or carrying out, those of ordinary skill would have a reasonable expectation of success. Both the suggestion and the reasonable expectation of success must be founded in the prior art, not in the applicant's disclosure. *In re Vaeck*, 20 USPQ2d 1438, 1442(CAFC 1991).

According to the Examiner, Claims 1-6, 9, 12-17, 20 of co-pending application No. 10/765,647 meet all the limitations of the instant claimed invention except the usage of BC1<sub>3</sub> gas and exposing the portion of the III-V semiconductor material to the etching mixture to

etch a smooth aspect ratio sidewall. According to the Examiner, Shul discloses a dry etching method for compound semiconductors that comprises the step of exposing the portion of the III-V semiconductor material to the etching mixture comprising  $\text{BCl}_3$ ,  $\text{CH}_4$  and  $\text{H}_2$  to etch smooth aspect ratio sidewall (col. 6, lines 42,45; Fig. 1).

The Examiner maintains that one skilled in the art at the time the invention was made would have found it obvious to modify Claims 1-6, 9, 12-17, 20 of copending Application 10/745,647 to include  $\text{BCl}_3$  in the gas etching mixture to etch a smooth aspect ratio sidewall in view of Shul's teachings, because Shul discloses that under the condition of using  $\text{BCl}_3$  and other etch parameters, the dry etch is highly anisotropic with a substantially smooth surface morphology (col. 6, lines 45-55).

With respect to current Claims 8 and 11, the present application requires a gas mixture of four gases in which the first gas is chosen from  $\text{HBr}$ ,  $\text{HI}$ , or  $\text{IBr}$ , and the remaining gases are  $\text{BCl}_3$ ,  $\text{CH}_4$ , and  $\text{H}_2$ . In addition, Claim 8 requires that the  $\text{BCl}_3$  is present in said reactor at a concentration of about 5 percent to about 75 percent by volume.

The cited claims in the co-pending application require a three gas mixture of a first gas chosen from  $\text{HBr}$ ,  $\text{HI}$ , or  $\text{IBr}$ , a second gas of  $\text{CH}_4$ , and a third gas of  $\text{H}_2$  to etch vertical features in a III-V semiconductor. The cited passages in Shul teach etching a III-V semiconductor in a five gas mixture of  $\text{BCl}_3$ ,  $\text{CH}_4$  and  $\text{H}_2$ ,  $\text{Cl}_2$ , and  $\text{Ar}$ .

First, to arrive at the present invention as claimed in Claim 8 from the teachings identified by the Examiner, one would have to add  $\text{BCl}_3$  to the mixture taught in the co-pending application. Shul teaches only that the 5 gas mixture under the specific reactor conditions provided therein provides a highly anisotropic etch with smooth sidewalls. The Examiner has not cited any passage in Shul that anisotropic etch and smooth sidewalls are the result of the  $\text{BCl}_3$ . Shul teaches that the  $\text{BCl}_3$  is added to etch Al containing layers, not that it provides the anisotropic etch and smooth sidewalls. Furthermore, Shul teaches that the results are highly dependent on a number of other parameters including the exact reactor conditions and the plasma composition. Hence, from the teachings of Shul, one cannot determine if the highly anisotropic etch with a substantially smooth surface morphology is the result of having  $\text{BCl}_3$  or  $\text{Ar}$ , or for that matter, only obtained with the five gases under the

specific conditions. Furthermore, since the results are highly dependent on other parameters, there is no reasonable expectation of success in making the specific change proposed by the Examiner. Thus, absent the specification of the present application as a guide, one would not make the suggested change. Accordingly, the Examiner's motivation for modifying the claims of the prior application by adding  $\text{BCl}_3$  is flawed. Hence, Applicant submits that Claims 8, 11, and the claims dependent therefrom are not obvious in view of the claims of the prior application and Shul.

Second, Claim 1 requires a specific concentration range for the  $\text{BCl}_3$  in the reactor. Shul teaches only the flow rates of gases into the reactor, not the concentrations within the reactor. Since gases are consumed in the reactor, one cannot determine the reactor concentrations from the teachings of Shul. Furthermore, the Examiner admits that Shul does not teach the concentration of the gas in question in the reactor (See the Examiner's argument with respect to the rejection of Claim 9). Hence, the Examiner has failed to show that a second limitation of Claim 1, and the claims dependent therefrom, is taught in the cited combination of references. Accordingly, there are additional grounds for allowing these claims.

With respect to Claim 20, the claim, as amended above, requires a three gas mixture,  $\text{BCl}_3$ ,  $\text{CH}_4$  and  $\text{H}_2$ , with the ratio of the second to third gasses being about 2:1. As noted above, Shul does not teach the ratio of gases in the reactor, Shul teaches only the ratio of flow rates of the gases. However, it is worth noting that Shul teaches that the ratio of flow rates of  $\text{CH}_4$  to  $\text{H}_2$  is 1:10; hence, if anything, Shul teaches away from the limitation in question. Accordingly, Applicant submits that Claim 20 as amended above is not obvious in view of the cited claims from the copending application and Shul.

The Examiner rejected Claims 1-5, 8, 10, 17, 19 under 35 U.S.C. 103(a) as being unpatentable over Tanabe, *et al* (hereafter "Tanabe") (US 6,893,971) in view of Shul, *et al* (hereafter "Shul") (US 5,624,529). Applicant traverses this rejection.

With respect to Claim 1, the Examiner looks to Tanabe as teaching all of the limitation of the claim except the limitation that  $\text{BCl}_3$  is present in said reactor at a concentration of about 5 percent to about 75 percent by volume. The Examiner looks to Shul

as teaching an etching system having the two gases in question in which  $\text{BCl}_3$  is present in the claimed concentration.

Applicant must disagree with the Examiner's reading of Shul. Shul teaches only the flow rates of gases into the reactor, not the concentrations within the reactor. Since gases are consumed in the reactor, one cannot determine the reactor concentrations from the teachings of Shul. Hence, the Examiner has failed to make a *prima facie* case for obviousness with respect to Claim 1, and the claims dependent therefrom.

With reference to Claim 8, the Examiner admits that Tanabe fails to disclose introducing  $\text{CH}_4$  and  $\text{H}_2$  into the reactor. The Examiner looks to Shul as disclosing exposing the portion of III-V semiconductor material to the etching mixture that comprises  $\text{BCl}_3$ ,  $\text{CH}_4$  and  $\text{H}_2$ . The Examiner maintains that one skilled in the art at the time the invention was made would have found it obvious to modify Tanabe by introducing  $\text{CH}_4$  and  $\text{H}_2$  into the reactor as per Shul because Shul discloses that for etching indium containing material, a preferred plasma composition includes  $\text{BCl}_3$ ,  $\text{CH}_4$  and  $\text{H}_2$  (col. 6, lines 43-46).

As noted above, Shul teaches only that the 5 gas mixture under the specific reactor conditions provided therein provides a highly anisotropic etch with smooth sidewalls. Furthermore, the 5-gas mixture does not include the first gas of Claim 1. The Examiner has not cited any passage in Shul that anisotropic etch and smooth sidewalls are the result of adding  $\text{CH}_4$  and  $\text{H}_2$ . Furthermore, Shul teaches that the results are highly dependent on a number of other parameters including the exact reactor conditions and the plasma composition. Hence, from the teachings of Shul, one cannot determine if the highly anisotropic etch with a substantially smooth surface morphology is the result of having  $\text{Cl}_2$ ,  $\text{BCl}_3$  or Ar, or for that matter, only obtained with the five gases under the specific conditions. Furthermore, since the results are highly dependent on other parameters, there is no reasonable expectation of success in making the specific change proposed by the Examiner. Hence, absent the specification of the present application as a guide, the Examiner's motivation for modifying the teachings of Tanabe to include the missing two gases is flawed. Accordingly, there are additional grounds for allowing Claim 8, and the claims dependent therefrom.

Similarly, with respect to Claim 19, which requires a three-gas mixture, the Examiner has used the present application as a guide in selecting one of the other gases in the five-gas mixture taught in Shul to add to the gas mixture taught in Tanabe. Hence, there are additional grounds for allowing Claim 19.

The Examiner rejected Claims 6, 9 and 18 under 35 U.S.C. 103(a) as being unpatentable over Tanabe in view of Shul and further in view of Bhardwaj, *et al* (hereafter "Bhardwaj") (US 6,261,962). The above amendments cancel Claims 6 and 18, and hence, render this rejection moot with respect to those claims. Applicant traverses the remaining rejection. Applicant repeats the arguments made above with respect to the missing teachings in the combination of Tanabe and Shul with reference to Claim 8, from which Claim 9 and 18 depend. The Examiner has not pointed to any teaching in Bhardwaj that provides the missing teachings.

The Examiner admits that even the combined references do not teach the additional limitation of Claim 9. The Examiner looks to Bhardwaj as teaching that the flow rate of etchants such as these gases can be varied. According to the Examiner, the claimed range is merely discovering an optimum result that requires only ordinary skill in the art.

As noted above, Shul teaches that the results obtained in the system taught in that reference are highly dependent on a large number of factors including the gas flow rates, temperature, specific substrates, etc. Hence, there are an overwhelming number of variables, and combinations thereof, to optimize. Absent the teachings of the present application, one of ordinary skill would not arrive at the claimed combination without undue experimentation. Hence, Applicant submits that there are additional grounds for allowing Claim 9

The Examiner rejected Claims 11-15 under 35 U.S.C. 103(a) as being unpatentable over Shul in view of Jewell, *et al* (hereafter "Jewell") (US 5,034,344). Applicant traverses this rejection.

With respect to Claim 11, the Examiner looks to Shul as teaching an etchant having a five gas mixture of  $\text{BCl}_3$ ,  $\text{CH}_4$  and  $\text{H}_2$ ,  $\text{Cl}_2$ , and Ar. The Examiner looks to Jewell as teaching that  $\text{Cl}_2$  can be replaced with  $\text{HBr}$  when etching In-based materials.

First, Applicant must disagree with the Examiner's reading of Jewell. The passage cited by the Examiner states that if one were to etch InP-based materials, the system consisting of Cl<sub>2</sub> and a noble gas based etchant would be modified by substituting either HBr or I<sub>2</sub> for the Cl<sub>2</sub> in that system. That is, one would use a two gas system consisting of HBr and a noble or I<sub>2</sub> and a noble gas. There is no teaching that such a change would be advantageous in any other etchant system. As noted above, Shul teaches that the results of the etching system taught therein are highly dependent on a number of parameters including the specific gases in the mixture. The Examiner has not pointed to any teaching in Jewell that the substitution in question would be beneficial in any other etchant system. Accordingly, Applicant submits that the Examiner has not made a *prima facie* case for obviousness with respect to Claim 11 or the claims dependent therefrom.

The Examiner rejected Claim 16 under 35 U.S.C. 103(a) as being unpatentable over Shul in view of Jewell and further in view of Demmin, *et al* (hereafter "Demmin") (US 6,635,185). Applicant traverses this rejection. Applicant repeats the arguments made above with respect to the rejection of Claim 11, Demmin does not provide the missing teachings.

In making this rejection, the Examiner admits that the combination of references does not teach the claimed concentration range. The Examiner attempts to overcome this problem by stating that Demmin teaches gas flow rates can vary and affect the results, and hence, the claim limitation is merely finding an optimum range that involves only routine skill in the art.

As noted above, Shul teaches that the results are highly dependent on a large number of factors including the gas flow rates, temperature, specific substrates, etc. Hence, there are an overwhelming number of variables, and combinations thereof, to optimize. Absent the teachings of the present application, one of ordinary skill would not arrive at the claimed combination without undue experimentation. Hence, Applicant submits that there are additional grounds for allowing Claim 16.

The Examiner rejected Claims 20-21 under 35 U.S.C. 103(a) as being unpatentable over Shul in view of Demmin. The above amendments cancel Claim 21 and place the

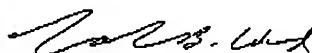
limitations of Claim 21 into Claim 20. Applicant traverses this rejection with respect to Claim 20.

In making this rejection, the Examiner admits that Shul does not teach the claimed gas ratio. The Examiner looks to Demmin as teaching that gas flow rates can be varied to optimize a similar etchant system, and hence, he claims that the claim limitation is merely finding an optimum range that involves only routine skill in the art.

As noted above, Shul teaches that the results are highly dependent on a large number of factors including the gas flow rates, temperature, specific substrates, etc. Hence, there are an overwhelming number of variables, and combinations thereof, to optimize. Absent the teachings of the present application, one of ordinary skill would not arrive at the claimed combination without undue experimentation. Hence, Applicant submits that the Examiner has not made a *prima facie* case for obviousness with respect to Claim 20.

I hereby certify that this paper is being sent by FAX to 571-273-8300.

Respectfully Submitted,



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